Evidence for the Sgoldstino in the Decay $\Sigma^+ \to p\mu^+\mu^-$

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Hyperon flavor-changing neutral-current decays provide ideal search windows for light pseudoscalar sgoldstinos with parity-conserving and flavor-violating interactions, as limits from kaon decays are not particularly strict. The HyperCP (E871) experiment collected $\sim 10^{10}$ hyperon decays in the 1997 and 1999 Fermilab fixed-target running periods. Using the data from the 1999 run, we report on the observation of three isolated events with reconstructed masses consistent with the hypothesis $\Sigma^+ \to p\mu^+\mu^-$. This is the rarest baryon decay ever observed. The dimuon mass distribution is unexpectedly narrow, suggesting the decay may proceed via an intermediate state of mass $214 \pm 0.5\,\mathrm{MeV}/c^2$. This state is consistent with a short-lived pseudoscalar sgoldstino with parity-conserving interactions decaying into two unlike-sign muons.